

SKETCHFAB-BASED DISCOVERY LEARNING AS AN INTERACTIVE RESOURCE TO ENHANCE SCIENTIFIC LITERACY ON THE DIGESTIVE SYSTEM

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ABSTRACT

Science literacy is an essential competency to be developed in elementary science education, yet Indonesian students' science literacy remains relatively low, particularly in understanding abstract concepts such as the human digestive system. This study examined the effect of Sketchfab-based discovery learning on improving elementary students' science literacy regarding the human digestive system. A quasi-experimental design with a nonequivalent control group was employed, involving 44 fifth-grade students, aged 10-11 years, with 22 students in each experimental and control class. The experimental class received instruction using Sketchfab 3D visualizations integrated with discovery learning, while the control class received conventional instruction. Data were collected through a science literacy test validated by expert judgment and tested for reliability using ANATES, yielding a coefficient of 0.71 (high reliability). Data were analyzed using the Shapiro–Wilk normality test, Levene's homogeneity test, N-Gain analysis, and the Mann–Whitney test in SPSS. Results showed the experimental class achieved a moderate N-Gain score of 0.42, while the Mann–Whitney test produced a significance value of 0.002 ($p < 0.05$), indicating a statistically significant difference between groups. These findings confirm that Sketchfab-based discovery learning effectively improves elementary students' science literacy.

Keywords: discovery learning; human digestive system; science literacy; sketchfab

INTRODUCTION

Science education in elementary school plays a crucial role in helping students develop scientific concepts and apply them to everyday phenomena. (Jirout & Pace, 2015) explain that children's understanding of scientific concepts develops progressively through experience, encompassing physical and biological concepts as well as scientific learning processes, including scientific reasoning. Therefore, elementary science learning should facilitate meaningful experiences that support conceptual development (Piaget, 1964). A primary objective of science education is to foster scientific literacy, defined as the capacity to comprehend scientific concepts and

interpret information accurately science-based information, and apply that knowledge to make responsible decisions (Ala & Yakin, 2025)

In the 21st century, scientific literacy has become an essential competency because students are required to cope with the increasingly rapid development of science and technology (Syofyan et al., 2025). Science literacy levels among students in Indonesia remain low. This is evident from the results of the Program for International Student Assessment (PISA), the findings suggest that the academic performance of Indonesian students remains below the international average (OECD, 2023).

The 2022 PISA results even show a decline in Indonesia's science literacy scores compared to the previous cycle. Students scored 383, which is still below the average of other OECD countries, which stands at 485 points (Kemendikbudristek, 2023)

Low levels of students' scientific literacy remain a significant challenge in science education. According to (Nawas, 2019), students' literacy achievement is influenced by various factors, including family socioeconomic status and parent educational attainment, with students from more advantaged backgrounds generally demonstrating higher literacy skills. In addition to these external factors, difficulties in understanding abstract scientific concepts also contribute to low science literacy (Syofyan et al., 2025).

For example, when learning about the human digestive system, students are required to comprehend the structure of internal organs and physiological processes that cannot be directly observed (Asy et al., 2025), making it more challenging for them to develop meaningful conceptual understanding and apply scientific knowledge in everyday contexts (Lawa et al., 2025).

(Singh & Khunyakari, 2023) also found that static images in textbooks often make it difficult for students to understand the material in depth. Therefore, learning media that can provide a more realistic and interactive learning experience are needed (Syawaludin et al., 2019). This situation underscores the need for educational innovations that can enhance student engagement in the learning process.

Advances in digital technology have opened up opportunities to use three-dimensional (3D) visual media in education (Heather et al., 2019). 3D visual

media allows objects to be viewed from various angles, making them appear more realistic (Salsabila et al., 2024). According to research (Alindra et al., 2024), using technology in education can make the learning process more engaging, interactive, and innovative. It can also enhance students' motivation and understanding during the learning process (Mustamin et al., 2025). One platform that can be used is Sketchfab. This web-based platform provides three-dimensional object models for interactive exploration (Aristov et al., 2021). Through Sketchfab, students can observe the structure of body organs in detail, zoom in, and explore specific parts independently (Dewi et al., 2025). Using this medium can help students understand abstract concepts and increase their engagement in learning (Astuti et al., 2025).

Several studies have shown that using Sketchfab positively impacts understanding of scientific concepts. (Purba et al., 2025) reported that integrating Sketchfab with conventional teaching aids enhances understanding of the digestive system. Similarly, (Nisa et al., 2025) found that Sketchfab enhanced student understanding of the respiratory system. Research conducted by (Karimah et al., 2025) also revealed that the use of Sketchfab had a positive impact on student science learning outcomes. Despite these promising findings, previous studies have primarily emphasized conceptual understanding and general academic achievement (Ritonga et al., 2024). Research specifically integrating Sketchfab with the Discovery Learning model to improve science literacy remains limited, particularly at the elementary school level (Gulo et al., 2024)

Students need to understand scientific concepts, analyze phenomena in their surroundings, and apply scientific knowledge to solve problems in daily life (Nuraeni et al., 2022). Given this gap, the novelty of this study lies in integrating the 3D visualization platform Sketchfab with the Discovery Learning model to enhance elementary school students' science literacy about the human digestive system. This approach not only uses interactive visual technology but also encourages students to discover concepts independently through exploration (García-Robles et al., 2024).

This study aims to examine the effectiveness of using Sketchfab 3D visualization media through the Discovery Learning model in improving elementary school students' science literacy regarding the human digestive system (Setyaningrum, 2025). Additionally, this study compares improvements in science literacy between students who learn through this medium and those who participate in inquiry-based learning.

Through this study, it is hoped that an alternative approach to science education can be identified that is more interactive, meaningful, and capable of improving science literacy among elementary school students.

METHOD

This study employs a quantitative approach. According to (Sugiono, 2024), quantitative research methods are applied to investigate a specific population or sample, utilizing research instruments and quantitative or statistical data analysis to test hypotheses. Consistent with this methodology, the present study adopts a pretest-posttest quasi-experimental design. In this quasi-experimental study, there are

two sample groups an experimental group and a control group, without subject randomization (Anantasia & Rindrayani, 2023)

A non-probability sampling technique, specifically purposive sampling, was employed (Pentang, 2023). The classes were selected based on comparable academic characteristics, curriculum, and learning conditions. Students who were not regularly enrolled or did not complete the pretest and posttest were excluded. Demographic and socioeconomic differences were not specifically controlled, as these variables were not measured in the study.

The sample was determined based on available classes and the balance of academic characteristics between the experimental and control groups. The study population consisted of all fifth-grade students at an elementary school in Purwakarta Regency. The study sample included 44 students, with one class assigned to the experimental group and another to the control group.

Table 1. Research procedure of the nonequivalent control group design.

Treatment	Pretest	X	Posttest
Experiment	O ₁	X ₁	O ₂
Control	O ₃	X ₂	O ₄

O1 = pretest result in the experimental class

O2 = posttest result in the experimental class

X1 = Treatment using Discovery Learning assisted by Sketchfab 3D visualization.

X2 = learning using Inquiry Learning

O3 = pretest result in control class

O4 = posttest result in control class

Table 1 shows that the experimental group received science instruction with Sketchfab 3D visualization tools implemented through the discovery learning model, whereas the control group received instruction based on the inquiry learning model (Creswell, 2017). The selection of these two models was based on research (Wulandari & Mustadi, 2019) these findings indicate that both approaches are effective in enhancing learning outcomes among elementary school students.

The lesson was designed based on science literacy indicators for the topic of the human digestive system. The research instrument consisted of a test comprising 10 multiple-choice questions and 5 essay questions, structured in accordance with the three science literacy indicators outlined by (OECD, 2025) interpretation of scientific data and evidence, evaluation of scientific investigations, and design of scientific investigations. The test instrument was administered as a pretest to assess students' initial abilities and as a posttest to evaluate improvements in learning outcomes after the instructional process (Erlinawati & Muslimah, 2021). Before use, the test instrument underwent validity and reliability testing (Forester et al., 2024)

Reliability testing was conducted on sixth-grade students who were not included in the research sample. The purpose of reliability testing was to determine the level of consistency of the test instrument before it was used in the study. According to (Ernawati et al., 2024), reliability is an indicator of a high-quality instrument because it demonstrates the stability of students' measurement results.

The reliability test in this study was conducted using the Anates 4.0 application to ensure the instrument's consistency and suitability before it was applied in the research class. The reliability coefficient obtained in this study was 0.71, indicating acceptable internal consistency. According to (Cruchinho et al., 2024), Cronbach's alpha values between 0.70 and 0.80 demonstrate acceptable reliability, suggesting that the instrument is appropriate for research purposes.

The data analysis for this study was conducted using SPSS version 16.0 in several stages. SPSS is a widely used application for processing and analyzing statistical data due to its advanced analytical capabilities (Ariyanto et al., 2023). Preliminary descriptive statistics showed a pretest mean of 77.60 (SD = 16.72, range 38.5–100.0) A normality test was conducted using the Shapiro-Wilk test, and homogeneity was assessed with Levene's test. The N-Gain was then calculated to evaluate improvements in students' science literacy after instruction, with results categorized as high, moderate, or low.

A Mann-Whitney test was conducted at a significance level of 0.05 to assess differences in science literacy improvement between the experimental and control groups. Through these steps, this study aims to determine the effect of using Sketchfab media based on Discovery Learning on improving elementary school students' science literacy regarding the human digestive system.

RESULT AND DISCUSSION

Improving Students' Science Literacy on the Topic of the Human Digestive System

This study began with the administration of a pretest to the

experimental and control classes to determine students' initial science literacy skills regarding the human digestive system. Next, the pretest data were analyzed to assess the equivalence of the initial abilities between the two classes. Subsequently, the test instrument used was found to be valid and reliable and passed the validity test using the Anates application, making it suitable for use in this study.

Table 2. Normality Test Results

Data	Pretest		Posttest	
	Experi mental Class	Contr ol Class	Experi mental Class	Contr ol Class
Sig. (Shapir o Wilk)	0.61	0.01	0.05	0.16
Interpre tation	Normal distribu ted	Not Norm al distri buted	Normal distribu ted	Norm al distri buted

Table 2 shows the results of the normality test for the learning outcomes of the experimental and control groups. The results demonstrate that the pretest data in the control group are not normally distributed, as the significance value is less than 0.05. Consequently, the data do not satisfy the assumption of normality. Prior to the hypothesis test, a homogeneity test was conducted to assess whether the variances of the two groups were equal.

Table 3. Results of the Homogeneity Test of Learning Outcomes

Data	Pretest	Posttest
Sig.	0.36	1.00
Interpretation	Homogeneous	Homogeneous

Levene's test results presented in Table 3 indicate significance values of 0.36 for the pretest and 1.00 for the posttest, both exceeding the 0.05

threshold. These results demonstrate that the variances between the experimental and control groups are homogeneous for both the pretest and posttest. After confirming the equality of data variances, the analysis continued by calculating the N-Gain to assess the improvement in students' science literacy following the instruction.

Table 4. Results of the Normalized Learning Gain Test

Data	Control Class	Experimental Class
Mean normalized gain	0.10	0.42
Categor y	Low	Moder ate

Table 4 demonstrates that the normalized gain in the experimental class was 0.42, categorized as moderate, while the control class achieved a normalized gain of 0.10, categorized as low. These results suggest that the intervention led to greater improvement in science literacy among students in the experimental class than in the control class.

The preliminary tests conducted showed that the learning outcome data in the experimental and control classes were not normally distributed, so the assumptions of the parametric tests were not met. Therefore, the data were analyzed using a nonparametric statistical test, namely the Mann-Whitney test. Nonparametric tests are used to compare two independent samples (Suhendra & Ineu Sulistiana, 2025). Before presenting the test results, the following section describes the implementation of instruction in the experimental class during the study.

Implementation of Sketchfab-Assisted Discovery Learning

The improvement in students' science literacy is closely linked to the learning process carried out during the study (Niu et al., 2025). Figure 1 shows the teaching materials used in the experimental class, instruction was delivered using a discovery-based learning model supported by Sketchfab regarding the human digestive system.

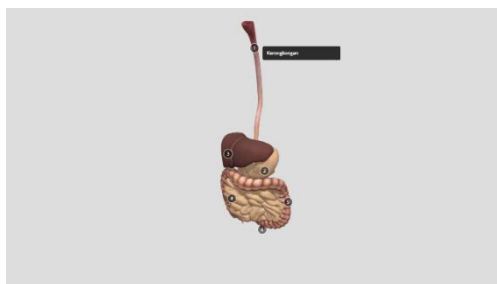


Figure 1. Sketchfab 3D model of the human digestive system

This learning model and three-dimensional media, as shown in figure 1 were designed to provide a more interactive learning experience, allowing students to explore concepts independently through observation, discussion, and discovery (Elvadola et al., 2022). Through these activities, students can gain a better conceptual understanding while also actively engaging in a learning process that supports the development of science literacy.



Figure 2. Learning process using Sketchfab

The experimental class followed the Discovery Learning model as specified by

the Ministry of Education and Culture (Wicaksono, 2022). This model comprises six stages: stimulation, problem statement, data collection, data processing, verification, and generalization.

This model is integrated with the Sketchfab platform, as shown in Figure 2. During the stimulation stage, students are provided with stimuli by observing a three-dimensional model of the human digestive system on Sketchfab to foster curiosity about the subject matter being studied. Next, in the problem statement stage, students identify issues and formulate questions based on their observations.

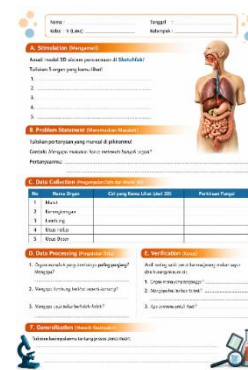


Figure 3. Student worksheet in the experimental class

Figure 3 presents the student worksheet used in the experimental class, developed following the Discovery Learning framework. The worksheet guided students through each stage of the learning process (Pratiwi et al., 2022) In the data collection stage, students gathered relevant information by exploring the Sketchfab 3D model, group discussions, and available learning resources.

The information obtained was then analyzed in the data processing stage to identify the relationships between the structure and function of the human digestive organs. In the verification stage,

students reviewed their findings through group discussions and presentations. Finally, in the generalization stage, students drew conclusions based on the learning outcomes achieved. This sequence of activities enabled students to participate in the learning process actively and supported the improvement of their science literacy.

Analysis of Improvements in Students' Science Literacy Indicators

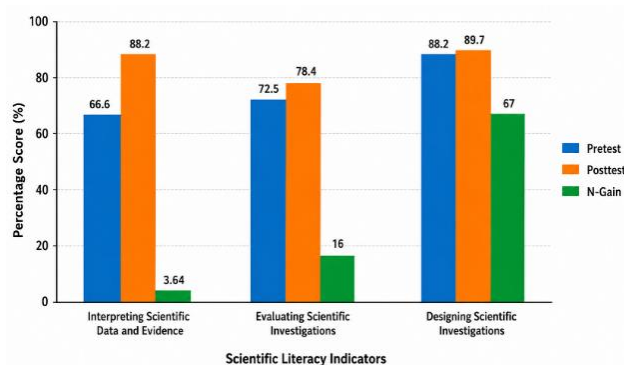


Figure 4. Graph showing the increase in science literacy indicators

Analysis of the science literacy indicators presented in Figure 4 shows that all indicators improved after instruction using Sketchfab-based Discovery Learning. The Interpreting Scientific Data and Evidence indicator increased from a pretest score of 66.6 to 88.2 on the posttest. The Evaluating Scientific Inquiries indicator rose from 72.5 to 78.4. The Designing Scientific Inquiries indicator, which had a comparatively high pretest score, exhibited only a slight increase from 88.2 to 89.7.

In addition to average N-Gain scores, analysis of individual-level gain distributions offers a more detailed understanding of student responses to the intervention. Categorising each student's normalised gain (g) as low ($g < 0.3$),

moderate ($0.3 \leq g < 0.7$), or high ($g \geq 0.7$) reveals considerable variation in the consistency of improvement across the three indicators. For the Interpreting Scientific Data and Evidence indicator, 35.3% of students achieved a high gain, 11.8% a moderate gain, and 52.9% a low gain. The Evaluating Scientific Inquiries indicator displayed a more balanced distribution, with 23.5% of students in the high category, 35.3% in the moderate category, and 41.2% in the low category. For the Designing Scientific Inquiries indicator, despite modest aggregate improvement, only 17.6% of students attained a high gain and 17.6% a moderate gain, while the majority (64.7%) remained in the low-gain category. This pattern is consistent with a ceiling effect, as many students had already achieved high pretest scores on this indicator, limiting the potential for further measurable improvement.

Using Sketchfab facilitates visualization of the human digestive system, transforming an abstract concept into a more tangible, comprehensible model. Interactive three-dimensional visualizations allow students to observe the structure of digestive organs from multiple angles without requiring complex laboratory equipment (Septiana & Fadhillah, 2024). This concrete and exploratory learning experience reinforces understanding through direct observation and supports the development of science literacy.

The integration of Discovery Learning and Sketchfab is believed to contribute to the improvement of students' science literacy (Karimah et al., 2023). Learning that combines discovery activities with three-dimensional visualization enables students to build

understanding from direct exploration and observation. Additionally, Sketchfab offers teachers an alternative for presenting abstract science concepts such as the human digestive system in a more concrete, interactive, and easily understandable visual format. This approach not only supports conceptual understanding but also facilitates the development of scientific skills, which are an essential component of science literacy.

The Effect of Sketchfab-Assisted Discovery Learning on Students' Science Literacy

Table 5. Results of the N-Gain Analysis

Data	Control Class	Experimental Class
<i>Mean normalized gain</i>	0.10	0.42
Category	Low	Moderate

As shown in Table 5, the experimental class exhibited a higher mean normalized gain compared to the control class. The experimental class achieved an N-gain score of 0.42, classified as moderate, while the control class obtained an N-gain score of 0.10, classified as low. These descriptive results suggest that students who participated in Discovery Learning with Sketchfab assistance experienced greater improvement in science literacy. To determine the statistical significance of this difference, a Mann–Whitney U test was conducted (Field, 2018).

Table 6. Results of the Mann-Whitney Test on Learning Outcomes

Test Statistic	Value
Mann-Whitney U	94.500
Z	-3.099
Asymp. Sig. (2-tailed)	0.002

The Mann–Whitney test results presented in Table 6 indicate an Asymp. Sig. (2-tailed) value of 0.002, which is below the 0.05 threshold. This finding demonstrates a statistically significant difference in science literacy improvement between the experimental and control groups. Consequently, the alternative hypothesis (H_1) is accepted and the null hypothesis (H_0) is rejected, indicating that the use of Sketchfab media based on Discovery Learning significantly enhances students' science literacy.

This finding aligns with (Waluyo, 2024) is asserted that when the significance value is less than the specified significance level, the alternative hypothesis is accepted and the null hypothesis is rejected. The Mann–Whitney test was selected for this study because the data violated the normality assumption, necessitating nonparametric statistical analysis (Nahm, 2016).

The significant improvement in science literacy in the experimental class is believed to result from the use of the Sketchfab 3D visualization tool integrated with the Discovery Learning model. This tool allows students to observe the structure of the human digestive system in a concrete way, thereby facilitating their understanding of abstract concepts. Through interactive visualization, students can explore learning objects from multiple

perspectives and relate the information they obtain to the concepts being studied.

Discussion

Bruner, as cited in (Ozdem & Kader, 2025) It is emphasized that knowledge is actively constructed through discovery and that the goal of science education extends beyond mastering scientific concepts to include developing scientific skills and attitudes essential for addressing real-world problems. Through the principle of learning by doing, students have the opportunity to observe, explore, gather information, and construct their own understanding based on their learning experiences (Damayanti et al., 2023).

The observed improvement in the designing scientific inquiries indicator can be attributed to the integration of Sketchfab 3D visualisation with the Discovery Learning model. The three-dimensional capabilities of Sketchfab enable students to examine digestive organs from various perspectives and observe their anatomical structures in detail. During the stimulation and data collection phases, students engaged with the 3D models to gather information about the structure and interrelationships of digestive organs. This process provided concrete data that facilitated the formulation of research questions, identification of relevant information, and development of problem-solving procedures. In the subsequent data processing and verification phases, students organised and validated the collected information before drawing conclusions. These activities likely provided more robust support for the development of scientific inquiry skills, with students actively participating in exploration, analysis, and verification

rather than passively receiving information.

This conclusion is supported by the statistical analysis, which accepts the alternative hypothesis and rejects the null hypothesis. Although Inquiry Learning emphasizes students' active engagement (Haerani et al., 2020), the limited use of visual representations in the control class led to suboptimal knowledge construction. In contrast to the experimental class, which was supported by three-dimensional visualizations via Sketchfab, students in the control class relied solely on two-dimensional images and verbal explanations. This resulted in slower development of students' ability to connect the structure and function of the digestive organs compared to the experimental class.

The results of this study indicate that improvements in science literacy are influenced by the implementation of Discovery Learning and the use of 3D visualizations from Sketchfab. The integration of these two approaches helps students construct conceptual understanding through concrete and interactive visual representations, making the abstract topic of the human digestive system easier to grasp. Interactive visualizations also allow students to observe organ structures from multiple perspectives and more comprehensively connect them to each organ's functions.

The integration of Discovery Learning and Sketchfab is believed to improve students' science literacy. Learning that combines discovery activities and three-dimensional visualization allows students to build understanding through direct exploration and observation. This approach supports the development of the ability to interpret data, evaluate, and design scientific

investigations, which is an important part of science literacy.

The findings of this study have important implications for improving science literacy in elementary schools. The low science literacy scores of Indonesian students in the PISA study highlight the need for innovative teaching methods to develop scientific thinking skills from an early age. The use of Sketchfab, a Discovery Learning-based platform, has the potential to serve as an alternative teaching method that supports the development of science literacy through more interactive, concrete, and meaningful learning experiences.

CONCLUSION

The findings demonstrate a significant difference in science literacy improvement between the experimental and control groups. Students in the experimental group showed greater improvement in science literacy than those in the control group. These findings suggest that Sketchfab-based Discovery Learning may support improvements in students' science literacy regarding the human digestive system.

In addition to improving overall science literacy, the integration of Sketchfab and Discovery Learning also enhances students' ability to interpret data and scientific evidence, evaluate scientific investigations, and design scientific investigations. The results indicate that integrating three-dimensional visualisation media with discovery-based learning can enhance students' knowledge construction and foster the development of scientific skills.

Therefore, integrating Sketchfab with Discovery Learning represents a promising alternative for enhancing

students' comprehension of abstract science concepts and science literacy in elementary education. Future research should employ randomised experimental designs, include larger and more diverse samples, conduct long-term assessments of learning retention, and implement the approach across various school contexts to evaluate its broader applicability.

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